



# Intelligent Lessons Learned Systems

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Department of Energy SELLS Spring 2000 Meeting



# Outline

- Observation on Lessons Learned (LL) processes
  - Bkgd: Artificial intelligence, knowledge management, case-based reasoning
  - Focus: *Systems* for lesson dissemination
- Characterizing LL systems
- Proposal for an intelligent *dissemination* sub-process
  - Motivation
  - Context
- Implementation in a decision support tool (HICAP)
  - Lesson representation
- Initial empirical evaluation
- Related work: Potential contributions from Artificial Intelligence
  - AAAI'00 Workshop on Intelligent Lessons Learned Systems



# Knowledge Management (KM)

An increasingly important business movement that promotes ***knowledge creation, sharing, & leveraging*** within an organization to maximize business results.

## Problems:

Financial constraints  
Loss of organizational knowledge

*Needs*

## Organizational Dynamics

Develop a culture  
for knowledge sharing

*Needs*

## Technology

Effective tools to capture,  
leverage & reuse knowledge

Most KM tasks are performed in the context of a well-defined (e.g., business) ***process***, and any techniques designed to support KM must be ***embedded*** in it



# Definitions Adopted

**Lessons Learned Process (LLP):** Implements a strategy for eliciting, retrieving, and reusing lessons obtained from experiential knowledge to continually support an organization (e.g., its decision-making quality).

**Lesson:** A *validated* record extracted from a (positive or failure) experience with a previous decision process that others in an organization can *reuse* to reinforce a positive result and/or avoid a failure (Secchi et al., 1999).

**Lesson Learned:** The change resulting from applying a lesson that *significantly* improves a targeted process (Bartlett, 1999).

**Lesson Learned System:** Software system that supports a LLP.



# Abstract Lesson Representation

- Originating action
- Action result
- Contribution
  - i.e., the new knowledge gained from this observation
- Applicable decision, task or process
  - e.g., from the Joint Universal Task List
- Conditions for *reuse*
  - i.e., an index
- Suggestion(s)
  - i.e., recommended response action, or *recommendation*



# Observation on lessons learned systems

- Based on a literature survey,
- The 1999 SELLS Spring Workshop
- The European Space Agency's Alerts and Lessons Learned Workshop (Fall, 1999)
- Relevant literature on knowledge management
- Relevant literature on artificial intelligence
  - AAI'00 Workshop on Intelligent Lessons Learned Systems

**Conclusion:** There is an apt popular analogy concerning the overly optimistic expectations for the usage frequency of standalone lessons learned retrieval systems, namely...



# If you build it...they will come.

- W. P. Kinsella

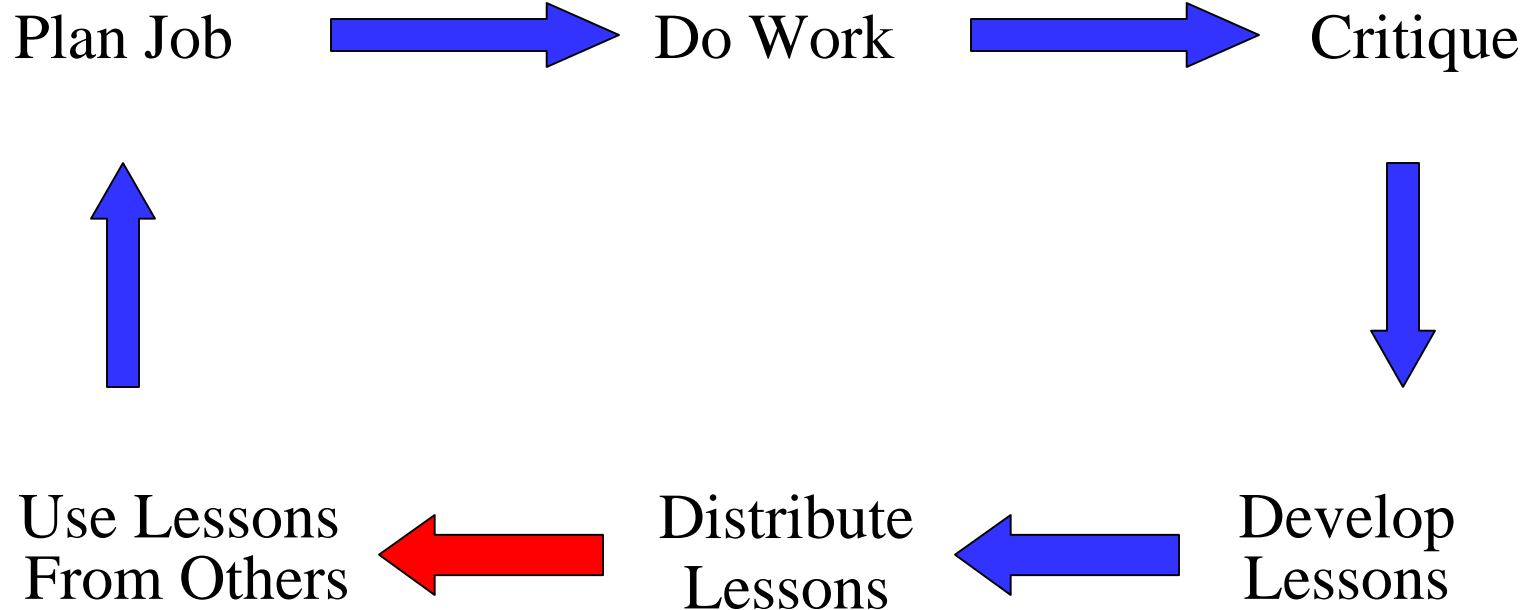


## Dyersville, Iowa

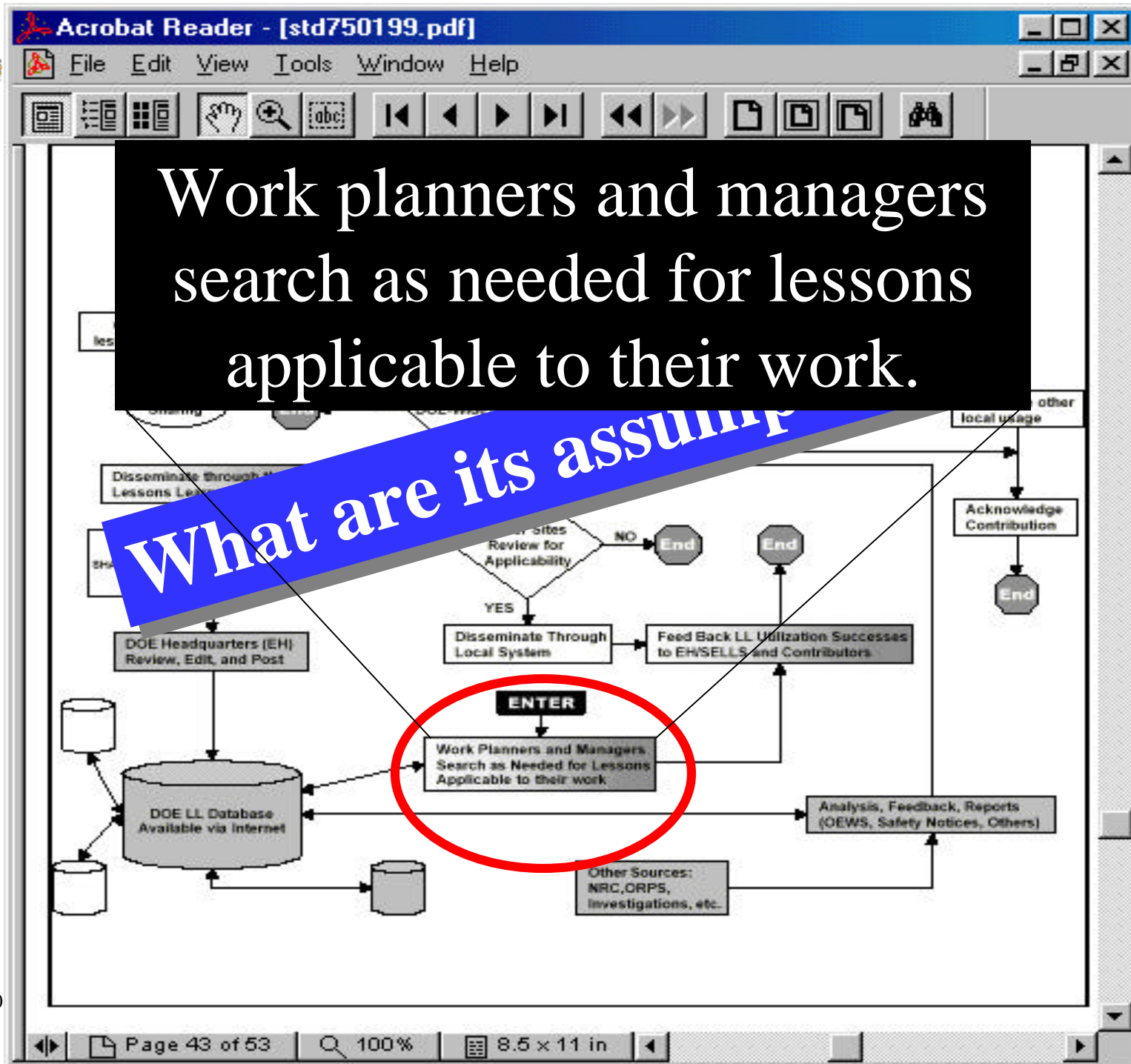
David W. Aha: Intelligent Lessons Learned Systems



# DOE's Lessons Learned (LL) Process









# Characterizing LL Systems

## Characteristics

## Values

### Contents

{Pure, Hybrid  $\subseteq$  {Lessons, Alerts, Best Practices}}

### Alerts:

- Derived from a negative experience
- Problems with an item used by several organizations
- Typically organized by a group of organizations that share the same technology and suppliers.

### Best practices:

- Successful ideas, applicable to organizational processes
- Capture only successful stories
- Not necessarily derived from specific experiences
- Intended to tailor entire organizational strategies



# Characterizing LL Systems

## Characteristics

## Values

Contents {Pure, Hybrid  $\subseteq$  {Lessons, Alerts, Best Practices}}

Organization type Dissemination  $\in$  {Adaptable, Rigid}

### **Adaptable:** (e.g., local DOE groups)

- Learned lessons are temporary placeholders of knowledge
- Lessons are incorporated into the process they impact
- A natural behavior of learning organizations (Senge, 1990)

### **Rigid:** (e.g., military)

- Doctrine/manuals cannot be updated quickly
- Some lessons will not ever be incorporated, but are retained
- LL process is not integrated with the targeted processes
- They typically resort to a **standalone** lessons retrieval tool



# Characterizing LL Systems

## Characteristics

## Values

Contents {Pure, Hybrid  $\subseteq$  {Lessons, Alerts, Best Practices}}

Organization type Dissemination  $\in$  {Adaptable, Rigid}

**Process type** {Managerial, Planning, Technical}

Often involves only one individual

- e.g., purchasing decisions

Typically distributed decision-making

- e.g., military planning, political campaign planning, resource management considerations

- e.g., design, construction engineering, equipment maintenance
- Characteristic of many NASA, ESA, CII, & DOE tasks



# Characterizing LL Systems

## Characteristics

## Values

Contents	{Pure, Hybrid $\subseteq$ {Lessons, Alerts, Best Practices}}
Organization type	Dissemination $\in$ {Adaptable, Rigid}
Process type	{Managerial, Planning, Technical}
<b>Target process relation</b>	<b>{Standalone, Embedded}</b>

Not integrated with the decision processes  
targeted by the lessons

Embedded in the lessons' targeted  
decision support system



# Characterizing LL Systems

Characteristics	Values
Contents	{Pure, Hybrid $\subseteq$ {Lessons, Alerts, Best Practices}}
Organization type	Dissemination $\in$ {Adaptable, Rigid}
Process type	{Managerial, Planning, Technical}
Target process relation	{Standalone, Embedded}
<b>Dissemination type</b>	{Passive, Active}
<div>Users must search for lessons</div>	
<div>Lessons are automatically brought to the user's attention</div>	



# Characterizing LL Systems

## Characteristics

## Values

Contents	{Pure, Hybrid $\subseteq$ {Lessons, Alerts, Best Practices}}
Organization type	Dissemination $\in$ {Adaptable, Rigid}
Process type	{Managerial, Planning, Technical}
Target process relation	{Standalone, Embedded}
Dissemination type	{Passive, Active}
<b>Recommendation</b>	{Browsable, Executable}

User can only *view* recommendation

User can *execute* recommendation



# DOE-Wide LL Process and (Some) Systems

## Characteristics

## Values

Contents	{Pure, <b>Hybrid</b> $\subseteq$ {Lessons, Alerts, Best Practices}}
Organization type	Dissemination $\in$ { <b>Adaptable</b> , Rigid}
Process type	{Managerial, Planning, <b>Technical</b> }
Target process relation	{ <b>Standalone</b> , Embedded}
Dissemination type	{ <b>Passive</b> , Active}
Recommendation	{ <b>Browsable</b> , Executable}





# Many have invested in LL processes/systems



## Air Force

- Air Combat Command Center for Lessons Learned
- Center for Knowledge Sharing Lessons Learned
- Automated Lessons Learned Capture and Retrieval System (ALLCARS)

## Army

- Center for Army Lessons Learned (CALL)
- Center for Engineers Lessons Learned (CELL)
- Medical Lessons Learned (AMEDD)
- US Army Europe - Lessons Learned Operating System

## Coast Guard

- Lessons Learned and Best Practices

## Joint Forces

- Joint Center for Lessons Learned (JULLS)

## Marine Corps

- Marine Corps Lessons Learned System (MCLLS)

## Navy

- Doctrine Command Lessons Learned System
- Combined Automated Lessons Learned (CALL @ NAWCAD)
- Naval Facilities Engineering Command Lessons Learned System

## Non-Military

- Construction Industry Institute (Lessons Learned Wizard)
- Decision Systems, Inc. (REASON)
- **DOE: Lessons Learned Services, SELLS, Project Hanford LL, etc.**
- **NASA Lessons Learned Information System**
  - **International Safety Lessons Learned Information System**
- **NASA-Goddard: RECALL: Reusable Experience with CBR for Automating Lessons Learned)**
- Canadian Army Lessons Learned Centre
- United Nations: UN Lessons Learned in Peacekeeping Operations



# Unclassified Examples from the Navy Lessons Learned System

(1/21/00)

<u>Department</u>	<u>Inactive</u>	<u>Active</u>	<u>Combined</u>	<u>“neo”</u>
Air Force	0	16,092	16,092	24
Joint	8,695	1,396	10,091	147
Marines	8,872	2,591	11,463	72
Navy	6,272	5,072	11,344	110
<b>Totals</b>	23,839	25,151	48,990	353

NEO = Noncombatant Evacuation Operation



# Navy LL System

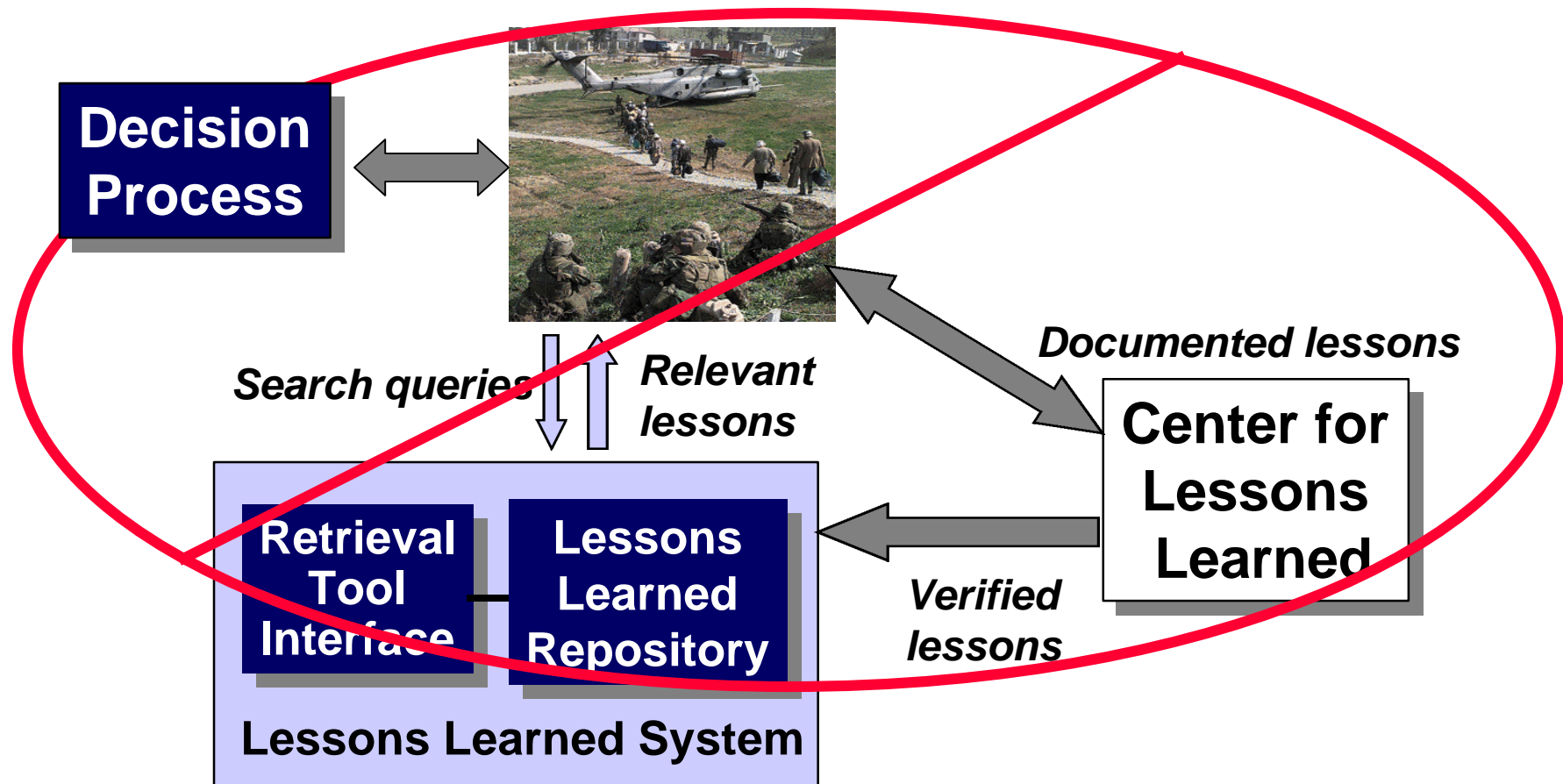
## Characteristics

## Values

Contents	{ <b>Pure</b> , Hybrid $\subseteq$ {Lessons, Alerts, Best Practices}}
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Process type	{Managerial, <b>Planning</b> , Technical}
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Dissemination type	{ <b>Passive</b> , Active}
Recommendation	{ <b>Browsable</b> , Executable}



# Standalone, Passive, Browsable Lesson Dissemination Sub-Process





# **Problem: Standalone, passive, browsers do not promote knowledge sharing**

## **Reasons:**

### **System issue**

- they are not well-integrated with other organizational processes

### **Information issue**

- lessons are often not well-defined, or are incomplete

### **Unrealistic user assumptions**

- users know about LL systems, and where to find them
- users have the time and the skills to search (i.e., learn to use) them
- users can correctly interpret the lessons and reuse them successfully
- users are reminded of their possible utility when needed



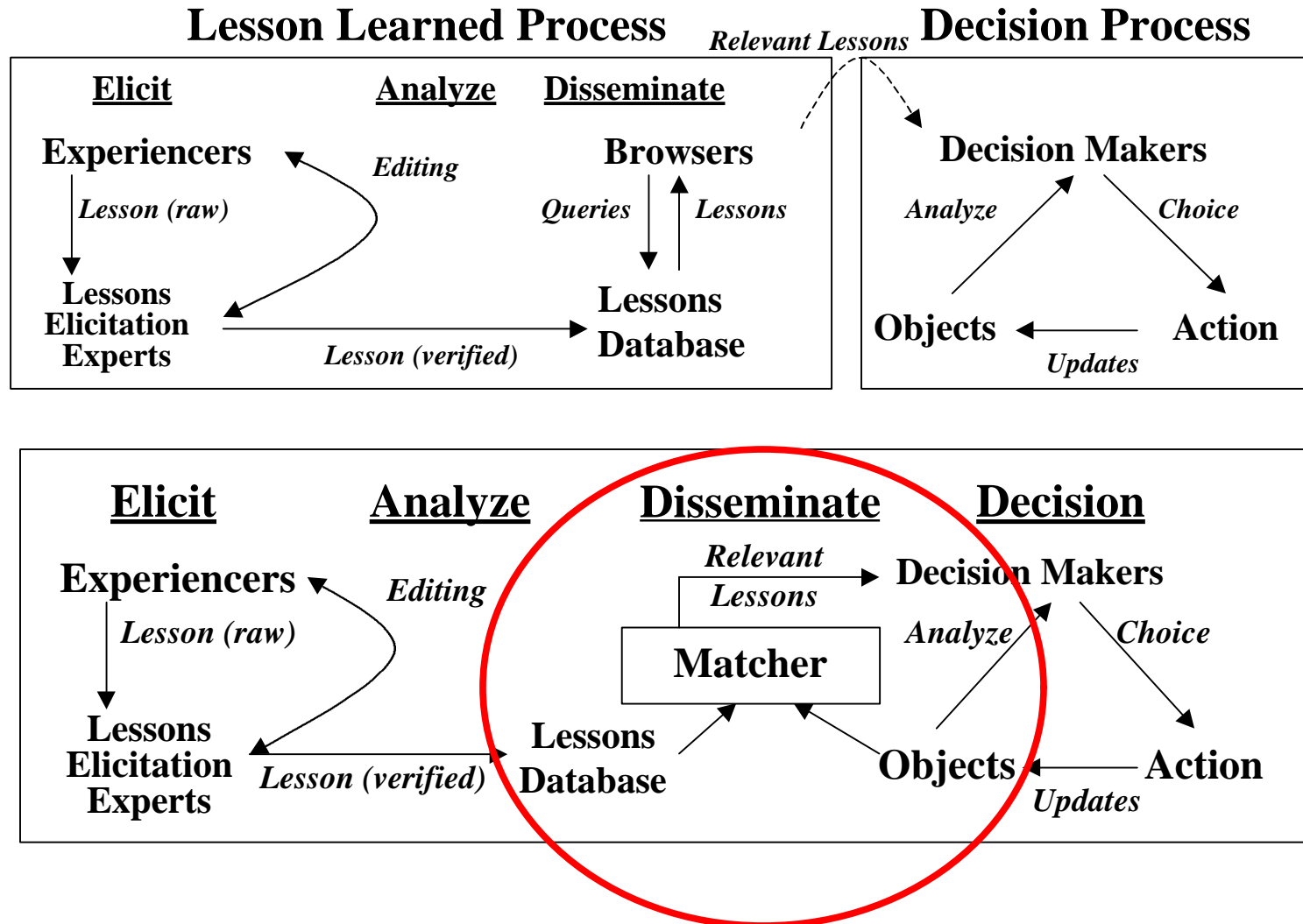
# Specifications for effective Lessons Learned systems

**Assumption:** Targeted decision process is on-line

- **Fully integrate the lessons learned process with the lessons' targeted decision processes.**
- **Shift burden from user to machine.**
  - Lessons are automatically brought to the user's attention rather than forcing the user to fetch them (in a separate process).
- **Automate lesson interpretation and recommendation.**
  - In their intended application's context
- **Ensure user control.**
  - User decides whether to accept a recommendation
  - Minimize number of unwanted intrusions

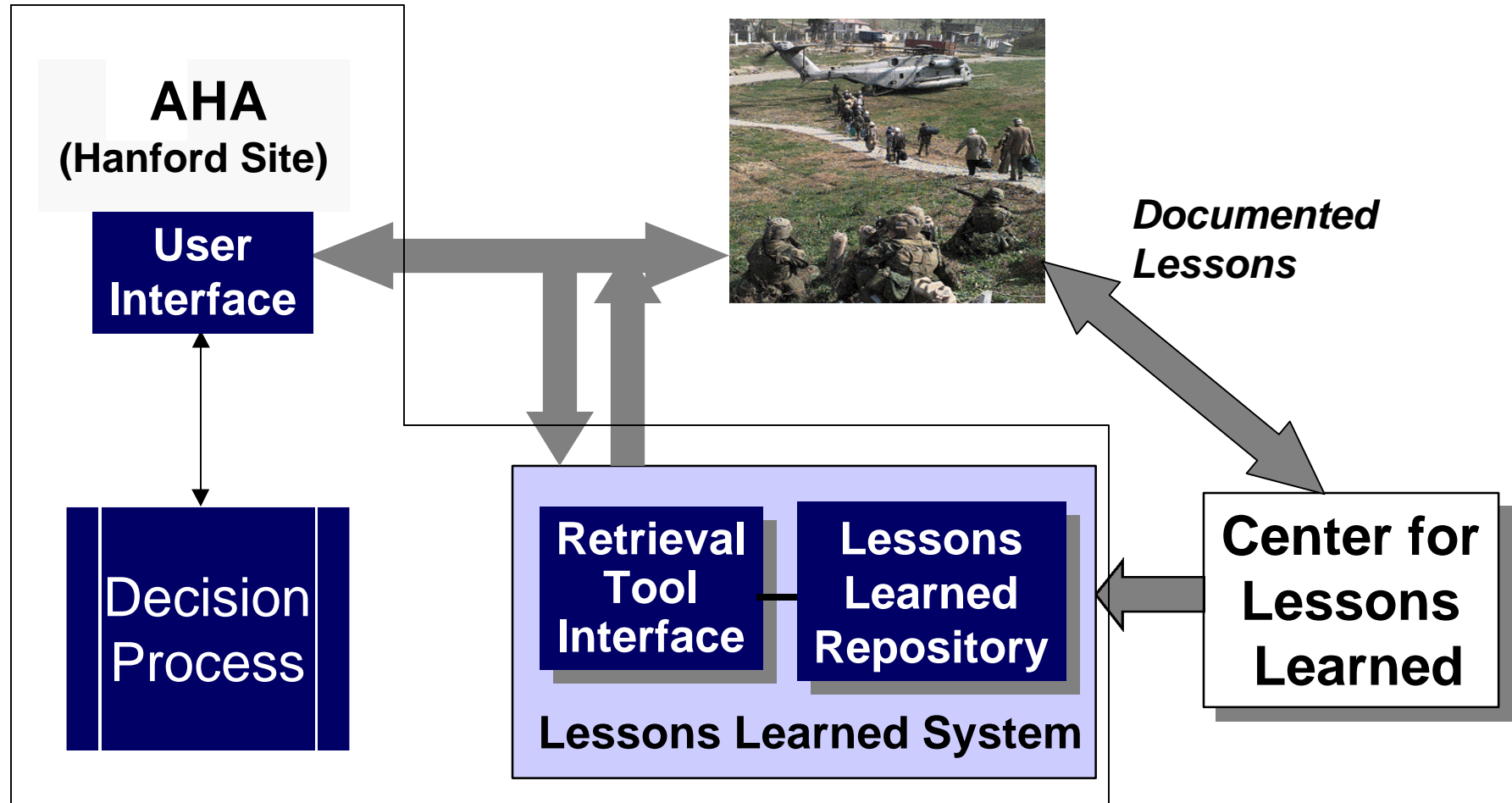


# From Separate to Integrated Processes





# Embedded Lessons Delivery







# AJHA (DOE, Hanford Site) LL System

(Bickford, 2000)



## Characteristics

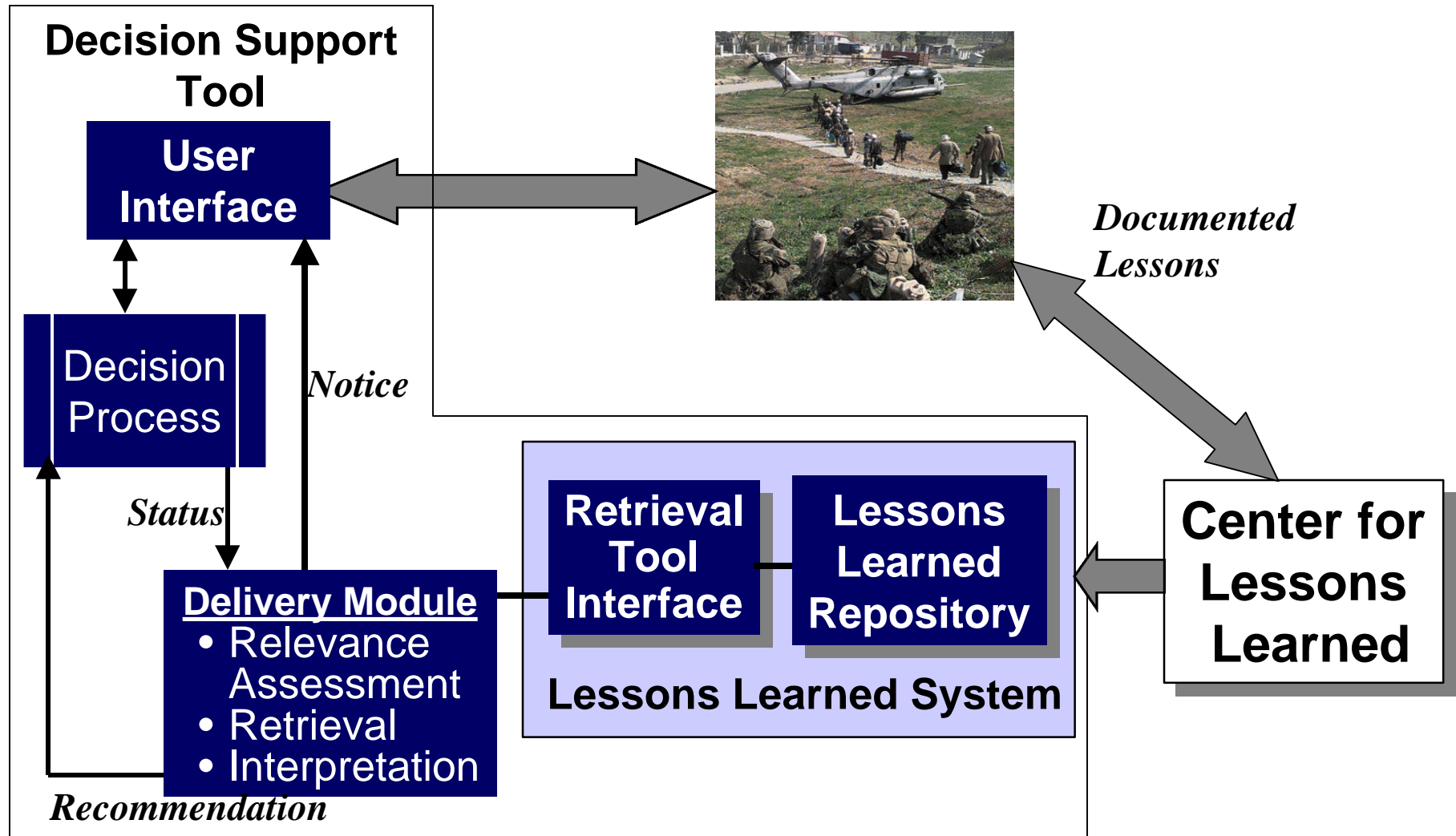
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Recommendation	{ <b>Browsable</b> , Executable}



# Proposal: Intelligent Lessons Delivery

(Weber et al., 2000)





# Benefits of Intelligent Lessons Delivery

- User doesn't need to know the LL module exists
- Reduced training/usage time
  - User doesn't need to learn a new process to use it
  - User is told about the lesson only if it is useful
- Lesson recommendations in context
  - Users do not need to interpret lessons
  - Suggestions are related to the current decision



# Context: Deliberative Planning for Noncombatant Evacuation Operations (NEOs)

- Goal: Assist DOS to evacuate noncombatants, nonessential military personnel, host-nation citizens, and third country nationals whose lives
- Characteristics:
  - Joint task force (often multinational)
  - Uncertainty
  - Complex (200+ tasks); Distributed
  - US Ambassador is senior authority



- Planning: Responsibility of geographic combatants
  - Resources: Doctrine, Exercises, DOS, EAP, etc.

• Problem: Lack of Computing Support!

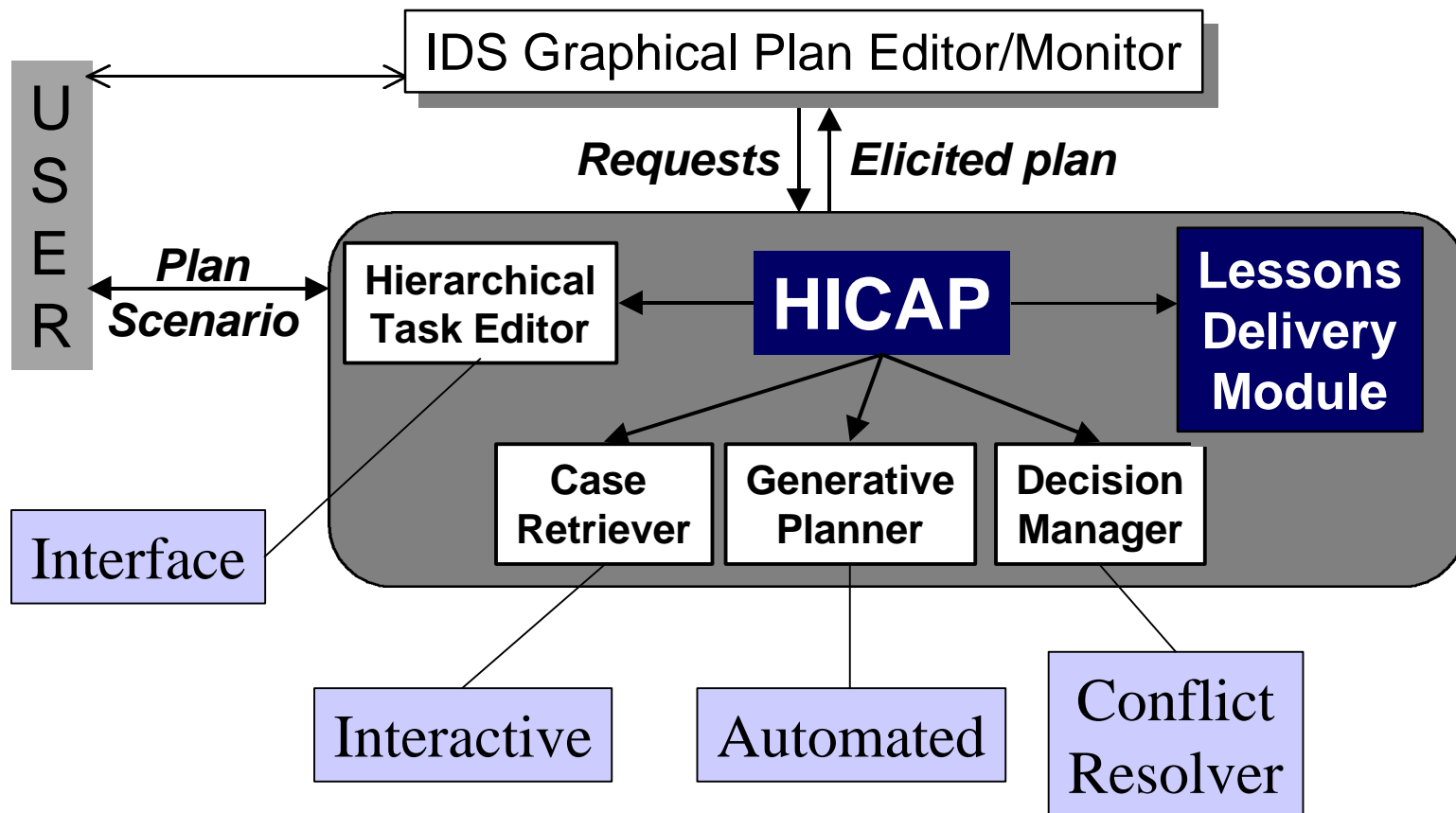


# Implementation in HICAP: A Plan Authoring Module



## Hierarchical Interactive Case-based Architecture for Planning

- Bridges the gap between doctrine and (modular!) experiences
- Java 1.2: [www.aic.nrl.navy.mil/~aha/cbr/hicap.html](http://www.aic.nrl.navy.mil/~aha/cbr/hicap.html)





# HICAP's Interface and Objects

- Task hierarchy
  - Tasks relations: Hierarchical
  - Task have durations

- 2. Resources
  - Hierarchical relations

The screenshot displays the HICAP / HTE interface with a task hierarchy on the left, a resource list on the right, and a world state dialog box in the foreground.

**Task Hierarchy (Left Panel):**

- xPosition CVBG
- xPerform through NEO
- xProvide Intensified Intel
  - xCollection assets in position
  - xPersonnel
- xLaunch/Recovery Cycle
  - xProvide AC-130 gun
    - xLaunch window
    - xCrew Availability
    - xAbility to coord. o
    - xFighter escort ava
- xProvide Fighter Escort
- xProvide standby refuel. se
- xProvide search and rescu
- Prepare NEO
- xTransit to Drapo by CH-53s
- xInsert Recon/SEAL team
- (FARP-decision)
- xEstablish FARP (ISB)
- Rescue mission
  - Move Helicopter(s) in zone
- x Land, load evacuees
- xTransit back FARP
- Organize & process evacuees
- Perform processing proced
- Perform evacuation

From: "Rescue mission"; To: "xPerform through

**Resources (Right Panel):**

- JTF Joint Task Force
  - CJTF Commander JTF & Staff
  - FARP force
  - Advance party
  - Air support
- Air Wing
- Helicopter Squadron
- TASK: Rescue mission

**World State Dialog Box (Center):**

Dialogue: Task = Rescue mission

New Subgoal Selected.

DESCRIPTION:  
Silver Wake: hostile detected

QUESTIONS:  
Are all evacuees concentrated in one site?: Yes  
Are there any hostiles between the ISB and the evacuees?: Yes

SUBTASKS:  
neutralize Danger  
send Helos

ORDERINGS: None

**Ranked Relevant Questions (with Answers or Scores)**

Answer / ...	Title
"Yes"	Are all evacuees concentrated in one site?
37	Are there any hostiles between the ISB and the evacuees?

**Ranked Cases**

Score	Title
50	Handle the situation in which hostiles are between ISB and eva...
50	Handle the situation in which it is unknown whether hostiles ar...
50	No hostiles